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The U.S. Government's Global Hunger & Food Security Initiative



An Introduction to Assessing Climate Resilience in Smallholder Supply Chains

USAID Feed the Future Learning Community for Supply Chain Resilience



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INTRODUCTION

Increasingly, companies recognize the need to plan for climate change to mitigate risk and realize commitments to the Sustainable Development Goals (SDGs) or other sustainability targets. Food and beverage companies in particular seek to evaluate the physical risks and, in some cases, opportunities associated with climate change within their supply chains. Ultimately, companies seek to translate climate risk intelligence into practical, operational strategies to build supply chain resilience. This guide offers food and beverage companies a working definition of climate resilience, plus an actionable process guide and sample indicator framework for diagnosing climate resilience in smallholder crop-focused supply chains.

For companies sourcing from smallholders, evaluating resilience to climate change poses particular challenges. Smallholder sourcing entails working with many, diverse farmer communities around the globe, each with its own agricultural practices, cultural context, and risk exposure. Moreover, companies often lack fine-grain visibility into smallholder performance due to the length of their supply chains. Even companies closer to smallholder farmers may seek guidance on how to translate data on climate risk and smallholder performance into targeted action plans across their sourcing geographies.

The guide breaks down the complex concept of resilience into manageable themes and suggests a five-step process for applying these themes with particular suppliers – namely smallholder farmers and intermediary aggregators (e.g., farmer cooperatives, small private processors) – to better understand and manage climate risk:

- 1. Know your risk: Identifying threatened geographies and crops**
- 2. Know your farmers: Identifying where risk sits in your supply chain**
- 3. Know your resilience: Matching risk to resilience capacity**
- 4. Know how to build resilience: Designing strategy or targeted interventions in response to diagnostic findings**
- 5. Know your progress: Monitoring through continuous measurement**

For readers interested in more detailed guidance on measurement methodology, indicators, or implementation, the guide includes references to external resources and potential partners with expertise in resilience monitoring and evaluation.

The guide draws from the collective experience of the USAID Feed the Future Learning Community for Supply Chain Resilience (Learning Community), a consortium comprised of climate scientists from the CGIAR Research Program on Climate Change, Agriculture, and Food Security (CCAFS) and the International Center for Tropical Agriculture (CIAT); the multi-stakeholder learning platform of the Sustainable Food Lab; and the agricultural lender Root Capital. The Learning Community offers this guide as a living document and welcomes input from readers. For more information, please contact Kealy Sloan at ksloan@sustainablefood.org or Elizabeth Teague at eteague@rootcapital.org.



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Food Security**



CCAFS



CIAT

International Center for Tropical Agriculture

IITA

Research to Nourish Africa



root capital



**SUSTAINABLE
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WHO SHOULD USE THIS GUIDE

This guide is designed for medium- to high-level decision-makers in food and beverage companies who are a) interested in smallholder climate resilience as a means of securing supply, and b) seeking guidance on creating resilience diagnostics and/or performance measurement plans. The guide is not intended as a detailed implementation guide for monitoring and evaluation (M&E) professionals, although it includes links to common resilience indicators and potential M&E partners (see Resources).

We recognize food and beverage companies play different roles in the supply chain, with different degrees of visibility into and control over farm-level realities, and that these roles will shape companies' motivations and options for engaging around smallholder resilience. This guide does not assume that all companies would or should engage in resilience interventions at the farm level. Rather, it offers an approach to framing smallholder resilience that could be used at various levels: to inform internal strategy, conversations with experienced third-party implementers or downstream suppliers, or sector-wide collaboration.

HOW TO USE THIS GUIDE

The “Resilience and Climate Smart Agriculture” section of this guide suggests a working definition and roadmap for measuring climate resilience in smallholder supply chains. The “Guiding Steps” section recommends common climate resilience approaches to measuring risk and resilience at the smallholder farmer and farmer aggregator (e.g., cooperative) levels. The remaining sections provide a broad look at the types of indicators a company may want to use for measurement and monitoring to inform strategy and also directs readers to existing resources and organizations with expertise in resilience monitoring and evaluation.

This guide complements and draws from the resilience decision-making tools under development by two

related initiatives funded by USAID: The Feed the Future Partnership for Climate-Smart Cocoa Initiative, and the Feed the Future Alliance for Resilient Coffee. We suggest companies read this guide first as an orientation on resilience in smallholder agricultural supply chains, and later use it as a roadmap for monitoring progress as they implement initiative tools designed to build farmer resilience.

Finally, this work builds on the broader guidance on performance measurement in smallholder chains created by the Sustainable Food Lab with its community of practice. Please refer to the document [“Toward a Shared Approach for Smallholder Performance Measurement: Common Indicators and Metrics”](#)¹ for additional detail on the practice of performance measurement.

¹ <http://www.sustainablefoodlab.org/performance-measurement/tools-resources/deep-dive/>

RESILIENCE AS ONE OF THE THREE PILLARS OF CLIMATE SMART AGRICULTURE

Agriculture is “both a victim of and a contributor to climate change.”² As a global community, we need to reduce agriculture’s contribution to climate change while building farmers’ resilience to climate shocks and preserving our natural resource base for the future.³

The Food and Agriculture Organization (FAO) captures this new vision for agriculture under the term “climate-smart agriculture.” Climate-smart agriculture encompasses three interlinked pillars: 1) sustainably increase productivity, 2) adapt and build resilience to climate change, and 3) mitigate climate change by reducing or removing greenhouse gas emissions where possible.⁴

*Figure 1: Three Pillars of Climate Smart Agriculture*⁵

Productivity	Adaptation & Resilience	Mitigation
Increase agricultural productivity and incomes from crops, livestock and fish without having a negative impact on the environment	Reduce the exposure of farmers to short-term risks, while also strengthening their resilience by building capacity to adapt and prosper in the face of shocks and longer-term stresses	Help reduce and/or remove greenhouse gas (GHG) emissions

² Montpellier Panel Policy Brief, “Farmers on the Climate Frontline: Six Recommendations for Addressing Agriculture in the UNFCCC Negotiations,” 2015.

³ Although the guide focuses on resilience to climate change, we understand that smallholder farmers face a number of other shocks, such as price volatility, for which the same principles of resilience apply.

⁴ Definition of Climate Smart Agriculture as provided by the Food and Agricultural Organisation of the United Nations (FAO), found at <https://csa.guide/csa/what-is-climate-smart-agriculture>.

⁵ For more information about Climate Smart Agriculture, see CGIAR’s CSA Guide (<https://csa.guide/csa/what-is-climate-smart-agriculture>).

A “climate-smart” program or strategy requires acting on the three pillars. Food and beverage companies have substantial experience measuring productivity and mitigation in their supply chains. However, most companies do not evaluate resilience, in part because they are just starting to confront this issue.

For that reason, this guide will focus on measuring the adaptation and resilience pillar at the level of companies’ “Scope 3” commitments (sourcing of raw materials, rather than direct operations or energy sourcing).⁶ By focusing on resilience, we do not discount the importance of the other two pillars, but rather recognize the existing resource base and expertise on productivity and climate change mitigation.

DEFINING RESILIENCE

The literature defines resilience as the capacity of a system to function in the face of disturbance. Resilient systems avoid, absorb, or adapt and transform around the disturbance in order to maintain their fundamental identity or operate within critical thresholds.⁷

Resilience is not a state of being, but rather a set of capacities that enables a system (such as a farm, farming family, or aggregator) to prevent or respond to threats to its health and stability (such as climate change). The literature recognizes three categories of resilience capacity, based on the intensity of response prompted by the disturbance:

⁶ The scope framework emerged as a tool to classify corporate greenhouse gas (GHG) emissions under the GHG Protocol Corporate Standard developed by the World Business Council for Sustainable Development and the World Resources Institute. Sustainable supply chain practitioners, such as the Sustainable Food Lab, have extended the framework to discuss other supply chain issues, including water conservation and improved farmer livelihoods. *The Sustainable Food Lab, “Scope 4: How to Grow Sustainable Sourcing to Measurable Impacts in Regions and Commodity Systems,”* 2015.

⁷ Holling 1973 via 3A; Carl Folke et al., “Resilience Thinking: Integrating Resilience, Adaptability and Transformability.”

Absorptive capacity to avert or minimize disturbances through preventative measures, short-term coping strategies, and incremental shifts in management practices (for example, a farming family invests in pesticides to control a seasonal pest outbreak on their coffee farm).

Adaptive capacity to make proactive and informed choices in the short to medium term about how to adapt to disturbances, including taking advantage of new opportunities arising from change (for example, a farming family introduces an irrigation system in response to changing rainfall patterns).

Transformative capacity to transition to an alternative stable state in the long term based on changing conditions (for example, a farming family replants with a new crop better suited to new climate conditions, thanks to access to alternative markets, to replace income from a former crop that has become unviable).

The three resilience capacities do not operate independently, but rather build on each other to create a continuum: absorptive → adaptive → transformative.

In order to be resilient, a system's resilience capacity must match the severity of the threat. When resilience capacity matches the threat level, a system can "bounce back" to its original state or even "bounce forward" to an improved state after a disturbance. When resilience capacity does not match the threat level, the system will not have the capacity to respond effectively to the threat and will "backslide," ending up worse than before the disturbance.

In the case of climate change and agriculture, scientists have created a tiered threat framework based on the severity of likely impacts to crop suitability and commercial viability.⁸ As the threat level increases, so does the degree of resilience capacity required to address the threat.

⁸ Vermeulen et al Vermeulen, S.J., Challinor, A.J., Thornton, P.K., Campbell, B.M., Eriyagama, N., Vervoort, J.M., Kinyangi, J., Jarvis, A., Läderach, P., Ramirez-Villegas, J., Nicklin, K.J., Hawkins, E., Smith, D.R., 2013. Addressing uncertainty in adaptation planning for agriculture. Proceedings of the National Academy of Sciences 110, 8357–8362. doi:10.1073/pnas.1219441110.

Absorb zones. Area will likely remain suitable for target crop production. Suppliers with the appropriate skills and resources can address shifts in climate conditions with incremental changes to practices.

Adapt zones. Area will likely remain suitable for target crop production, although suitability will decline. In some cases, area may shift from ideal to marginal for production of the target crop. Suppliers will need to adapt their practices to remain commercially viable.

Transform zones. Area will no longer be suitable for target crop production without major adaptation. Suppliers may find it more viable to transition to transition to alternative crops or livelihoods strategies, or migrate.

In other words, in absorb zones farmers need the capacity to mitigate or minimize relatively minor shifts in existing weather variability or shocks, while those in transform zone need the capacity to transform their business strategy in response to the “new normal” under climate change.

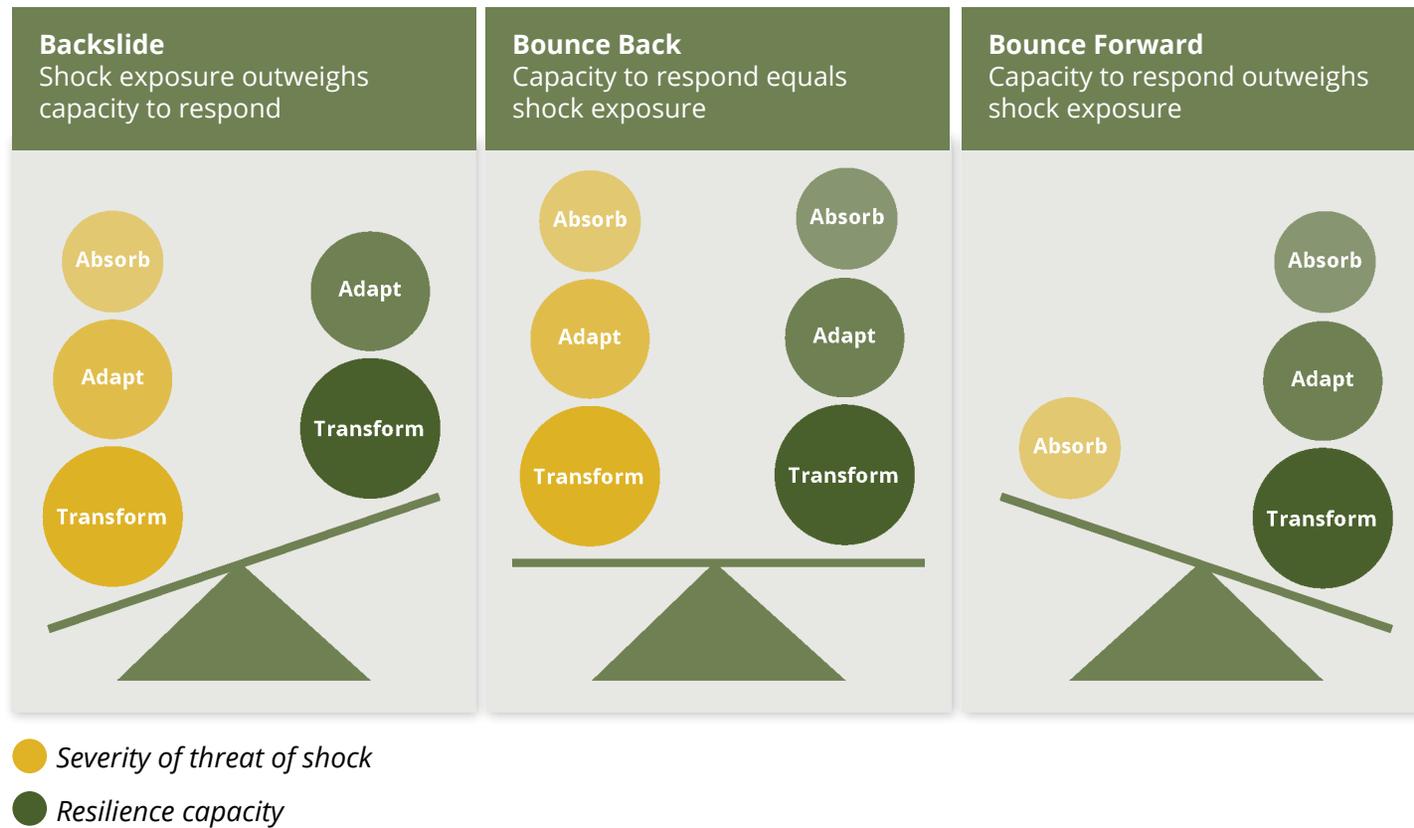
If we apply this definition of resilience to smallholder supply chains in the age of climate change:

Our system is the smallholder supplier base (focused on farmers and farmer aggregators, like cooperatives). Companies may focus on their entire supply chain or on sub-components, such as supplier segments or geographies.

Our disturbance is climate change. While a global phenomenon, the specific disturbances associated with climate variability and climate change vary significantly across contexts and are influenced by natural risk exposure, such as altitude, erosion and slope. We discuss climate risk analysis under Step 1 in the “Guiding Steps” section.

Resilience captures the capacity of the supply chain to operate and prosper in the face of climate change.

Figure 2: Ability to manage shock based on supply chain resilience capacity and severity of threat of shock



Putting our definitions together, we can present a vision of resilient smallholder supply chains:

We envision more resilient, or less vulnerable, smallholder farmers: farmers with the skills and resources to absorb weather shocks in the short-term, greater capacity to adapt to changing climatic conditions in the medium- to long-term, and/or the ability to transform in the long-term. Resilient farmers will have the strength and the flexibility to manage through climate change, emerging from disturbances with similar or improved wellbeing (e.g., will “bounce back” or “bounce forward”).

We believe intermediate aggregators, like farmer cooperatives, can play a key role in building farmer resilience to climate change – if they in turn have the capacity to manage through the disruptive effects of climate change while retaining their identity as viable enterprises serving rural communities.

Therefore, our vision requires more resilient, or less vulnerable, intermediate aggregators: enterprises with the skills and resources to absorb weather shocks in the short term, greater capacity to adapt to changing climatic conditions in the medium to long term and/or the ability to transform in the long term.

Ultimately, this framing emphasizes the agency of supply chain partners. Resilient farmers and businesses have, as the international advocacy organization Oxfam writes, “hope for the future and [the capacity to make] real choices about how to live their lives and adapt to change.”⁹

⁹ Oxfam, “Framework and Guidelines for Resilience Programming” (internal document described in discussion paper: “Resilience in Impact Evaluations: Lessons Learned from Measuring Resilience in Oxfam’s Large-N Effectiveness Reviews,” December 2015)

RESILIENCE

Resilience is not a state of being, but rather a **set of capacities** that enables a system (such as a farm, farming family, or aggregator) to **prevent or respond to threats to its health and stability** (such as climate change).

GUIDING STEPS

While specific measurement needs will vary based on context and learning objectives, in practice companies likely share common questions related to measuring and building resilience in their supply chains. Adopting a common approach can be beneficial to both companies and their suppliers, improving measurement efficiency and effectiveness, reducing reporting burden on suppliers and farmers, and fostering more effective community learning by making data more comparable. This section proposes a series of guiding steps 1 to help companies focus their own resilience performance measurement practice with upstream suppliers, including suggested common topline indicators to measure resilience capacities.

1. Guiding questions are modeled after Mercy Corps, "Our Resilience Approach" https://www.mercycorps.org/sites/default/files/Mercy%20Corps%20Resilience%20Approach_April%202015.pdf



INTRODUCTION

ABOUT
THIS GUIDE

RESILIENCE &
CLIMATE SMART
AGRICULTURE

GUIDING
STEPS

COMMON
INDICATORS

RESOURCES

KNOW YOUR RISK





1. KNOW YOUR RISK: IDENTIFYING THREATENED GEOGRAPHICS AND CROPS

See
Resources
section for
more
information

(Steps One: Know your Risk and Two: Know your farmers are iterative. Companies may need to go through the steps at the same time until they get to a level of detail they are satisfied with.)

To best manage climate risk in their supply chains, companies need to be able to prioritize areas where resilience is critical for future supply security.

While a global phenomenon, the specific disturbances associated with climate change vary across contexts. Climate change causes both discrete, short-term shocks, such as unusual weather variability or floods; and gradual, longer-term stressors, such as multi-year warming trends. Climate shocks and stressors may be idiosyncratic, only affecting particular communities or suppliers, or they may be covariate, simultaneously affecting large swathes of the supply chain. Climate shocks or stressors will also affect specific crops or crop varieties to different degrees, depending on their genetic characteristics. For example, cocoa can generally stand higher temperatures than coffee but needs higher levels of precipitation; or certain varieties of Arabica coffee are bred to be more resistant to drought than others.



CASE STUDY: Keurig Green Mountain and its Coffee Under Pressure project

Throughout this section, we reference a resilience measurement initiative of Keurig Green Mountain (at the time, Green Mountain Coffee Roasters) as a case study. Keurig launched its Coffee Under Pressure (CUP) project with CIAT and Catholic Relief Services to assess resilience in its coffee supply chain in Central America. Ultimately, the roaster sought to strengthen its smallholder farmer partners' capacity to respond to climate change while managing the security of its supply.

To determine suppliers' exposure to climate change risk, companies may rely on a combination of historic climate data, recent climate and weather observations, and modeled climate projections. Comparing recent climate trends to historic records provides insights on current risks to inform short-term decision-making. For longer-term planning, climate models can simulate the future impacts of climate change within specific areas and for specific crops, identifying climate risks over the next 15, 30, or 50+ years.¹⁰ Both historical climate data and climate model outputs are publicly available through resources like the ones found in the accompanying resource guide to this section. Companies may ground-truth external data with field observations on current climate threats or trends from suppliers, procurement staff, technical assistance partners, or local researchers.

Table 1 provides an illustrative example of a climate risk dashboard.¹¹

10 For details, we recommend the following example, looking at the likely impacts of climate change on the production of Arabica and Robusta coffee: Bunn, C., Läderach, P., Ovalle Rivera, O. et al, "A bitter cup: climate change profile of global production of Arabica and Robusta coffee," *Climatic Change* (2015) 129: 89. Available online at: <https://doi.org/10.1007/s10584-014-1306-x>.

11 Adapted from the Climate Change Knowledge Portfolio of the World Bank using the Representative Concentration Pathway (RCP) 4.5. Available online at: <http://sdwebx.worldbank.org/climateportal/index.cfm>.



Table 1: Illustrative climate risk dashboard for coffee in Honduras under an intermediate climate modeling scenario

Climate Risk	Timing	Where	Potential Impacts on the Coffee Tree	Potential Impacts on the Coffee Supply Chain
Warmer Temperatures	~0.8C-2.5°C by 2050; ~1-3.7°C by 2100	Strongest impacts in the northeast	<ul style="list-style-type: none"> • Physiological effects, resulting in declining productivity/quality • Change in suitability zones: optimum altitude will migrate upward from 600-1200 msl to 900-1400 msl 	<ul style="list-style-type: none"> • Lower productivity and over production from tree damage/death, reduced suitability • Reduced quality from plant stress, pests and diseases, irregular flowering • Increased supply chain disruptions from severe weather events
Erratic Rainfall	Already present	Uncertain	<ul style="list-style-type: none"> • Greater flowering frequency • Greater fungal disease and/or pest incidence • Increased soil erosion 	
Stronger Dry Season	Gradual until end of century	Strongest impacts in the “dry corridor” in the south	<ul style="list-style-type: none"> • Weaker trees, wilting, tree death 	
Increased Frequency/Severity of El Niño Events	Gradual	Strongest impacts on the Pacific slope in the southwest	<ul style="list-style-type: none"> • Tree damage and/or death • Increased soil erosion and/or landslides 	

In the case of climate change and agriculture, scientists have created a tiered risk framework based on the severity of likely impacts to crop suitability and commercial viability¹²:

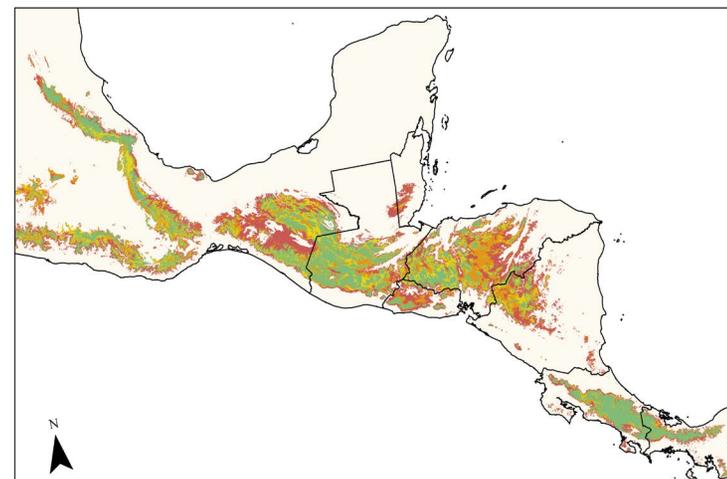
Opportunity. Area will likely increase in suitability for target crop production.

Absorb. Area will likely remain suitable for target crop production. Suppliers with the appropriate skills and resources can address shifts in climate conditions with incremental changes to practices.

Adapt. Area will likely remain suitable for target crop production, although suitability will decline. In some cases, area may shift from ideal to marginal for production of the target crop. Suppliers will need to adapt their practices to remain commercially viable.

Transform. Area will no longer be suitable for target crop production without major adaptation. Suppliers may find it more viable to transition to alternative crops or livelihoods strategies, or migrate.

Using this risk framework, companies can pinpoint supply chain segments most exposed to climate change risk. Companies can then identify suppliers and partners in high-risk chains for potential resilience interventions.



Arabica gradient of impacts
RCP 6.0 - 2050s

Transform Absorb Adapt (minor) Adapt (major) Opportunity



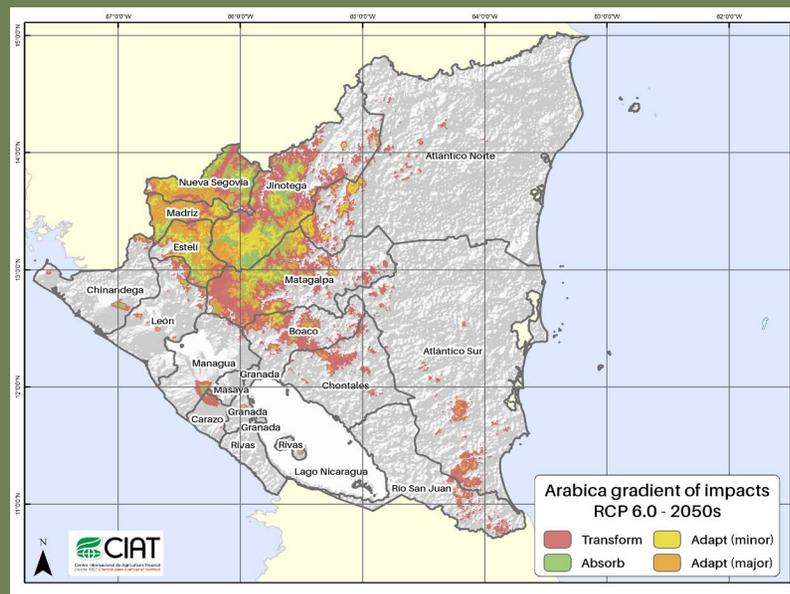
12 Suitability and impact gradient maps from Bunn C, Castro F, Lundy M (2017) The impact of climate change on coffee production in Central America. San Pedro Sula, Honduras.

CASE STUDY: Keurig Green Mountain and its Coffee Under Pressure project

The CUP program started with an analysis of Keurig suppliers' exposure to climate change risk. CIAT scientists worked with global climate models to identify likely future climate impacts on coffee production within several of Keurig's sourcing countries in Central America. Ultimately, the research team used the models to map climate risk as a function of likely changes to coffee growing suitability, using the absorb/adapt/transform categorization discussed above.

According to CIAT's climate modeling, the climate across Central America will become hotter and drier – and less suitable for Arabica coffee production. In Nicaragua, for example, the models project a two-degree Centigrade increase in average temperatures and a five-percent decline in annual precipitation by 2050, compared to the period of 1950 to 2000. The country should see roughly half the expected impacts by 2020. The models project climate change will reduce the area suitable for coffee production in Nicaragua by around 30 percentage points.¹³ Most of the country's coffee-growing regions fall into the "adapt" or "transform" categories.

The CUP team complemented the modeling and maps with on-the-ground information from focus groups with Keurig suppliers. Farmers reported seeing changes in temperatures and precipitation patterns that aligned with the projected climate trends, confirming the direction of the model projections.



¹³ CIAT, "Escenarios del Impacto del Clima Futuro en Areas de Cultivo de Café en Nicaragua: Informe Final," 2012.

INTRODUCTION

ABOUT
THIS GUIDE

RESILIENCE &
CLIMATE SMART
AGRICULTURE

GUIDING
STEPS



COMMON
INDICATORS

RESOURCES

KNOW YOUR FARMERS





2. KNOW YOUR FARMERS: IDENTIFYING WHERE RISK SITS IN YOUR SUPPLY CHAIN

(Steps One: Know your Risk and Two: Know your farmers are iterative. Companies may need to go through the steps at the same time until they get to a level of detail they are satisfied with.)

Once companies have pinpointed climate risk “hotspots” within their sourcing regions, they can then identify which suppliers are operating within those hotspots and how much supply comes from each climate risk zones (absorb, adapt, transform). As mentioned above, the selection of the focus area is an iterative process, requiring both climate data and knowledge of sourcing areas to identify priority populations.

The dashboard below shows a simplified version of how a company may begin to identify focus areas based on climate risk and volume of supply. Other variables may be included to fit companies’ strategic needs.

Table 2: Illustrative climate hotspot dashboard

Country	Specific Location	Crop	Risk Zone	Field Intelligence	# Farmer Suppliers	% of Supply
Ghana	Kumasi	Cocoa	Adjust	Decreased rainfall during the dry season leading to reduced yield	10,000	25%



INTRODUCTION

ABOUT
THIS GUIDE

RESILIENCE &
CLIMATE SMART
AGRICULTURE

GUIDING
STEPS



COMMON
INDICATORS

RESOURCES

KNOW YOUR RESILIENCE





CASE STUDY: Keurig Green Mountain and its Coffee Under Pressure project

Once Keurig and its partners had mapped climate risk, the team identified coffee farmers and cooperatives operating within each risk zone, using internal information. The project team selected a subset of farmers within each zone for a resilience diagnostic (see next box).

3. KNOW YOUR RESILIENCE: MATCHING RISK TO RESILIENCE CAPACITY



*See
Resources
section for
more
information*

Armed with climate risk data, companies next need to understand the resilience capacity of their supply chain by diagnosing the capacity of suppliers' to absorb weather shocks in the short term, and adapt to or transform with changing climatic conditions in the medium to long term.

Measuring resilience capacities poses several challenges. Most significantly, measuring resilience capacities is usually an ex-ante exercise rather than a typical case of ex-post performance measurement. Companies want to understand supplier capacity to withstand shocks in the future based on information available in the present. Complicating matters, resilience capacities are often invisible skills, such as the ability to rely on extended family in times of financial hardship or the entrepreneurial capacity to forge a new livelihood path. Companies cannot directly observe or ask about these capacities as they would observe farm practices or ask about household yield of a certain crop.

In response to these methodological complexities, companies can identify proxy indicators in the form of

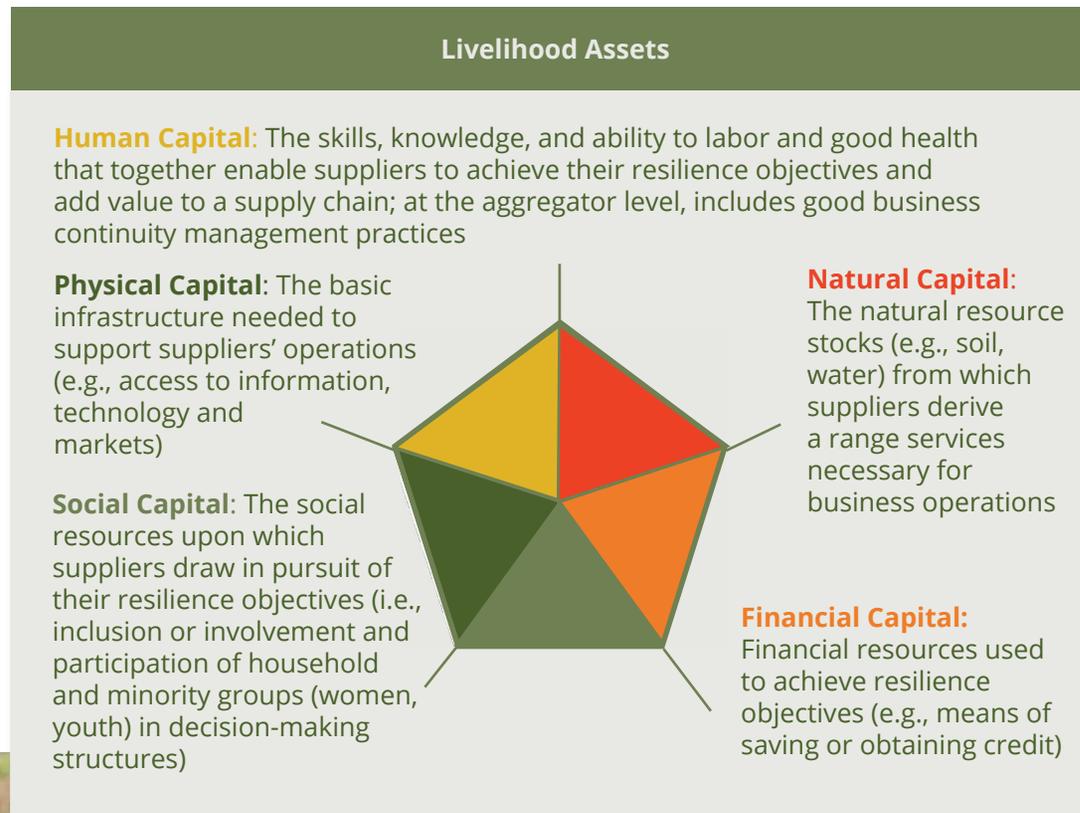




measurable assets, characteristics, or practices that likely influence resilience capacity. Using proxies, companies can gain a snapshot of suppliers' resilience capacity in the present moment and identify gaps in their ability to manage through future disturbances (and later, monitor progress in resilience capacity over time).

To identify proxies for resilience capacities, we turn to the Sustainable Livelihoods Framework,¹⁴ a tool widely used among agricultural supply chain practitioners and researchers that identifies five types of assets or capitals (financial, human, natural, physical, and social) critical for resilient livelihoods.

Figure 3: Livelihood assests



We use the livelihoods asset framework to suggest topline, proxy indicators for each of the three resilience capacities (absorb, adapt, transform).¹⁵ Indicators are based on a literature review and the direct field experience of the Learning Community. We include indicators for both farmer households and farmer aggregators (e.g., cooperatives or private traders).

¹⁴ The Sustainable Livelihoods Framework was developed by The United Kingdom's Department for International Development (DFID).

¹⁵ An illustrative excerpt of indicators is found in Table 3 and a fuller set of example indicators in Appendix A.



Note proxy indicators of capital may contribute to different resilience capacities (absorb, adapt, transform) depending on the timeframe and application of the capital (i.e., a capital may build absorptive capacity if used to prevent or mitigate short-term shocks, or may contribute to adaptive capacity if used to prepare for future shocks or longer-term stressors).¹⁶ For example, a farmer that regularly irrigates to make soil more suitable for a crop during seasonal dry times displays absorptive capacity, while a farmer that installs an irrigation system in response to several seasons of irregular drought displays adaptive capacity. While Table 3 suggests categorization of certain key indicators, companies may reorganize indicators based on their context and objectives.

¹⁶ COSA (2017): Simpler Resilience Measurement: Tools to Diagnose and Improve How Households Fare in Difficult Circumstances from Conflict to Climate Change. Committee on Sustainability Assessment (PA), Ford Foundation (NY).

¹⁷ We define “climate-ready” crops or crop varieties as those more suited to likely future climate conditions within a given context.

Table 3: Illustrative example of resilience capacity indicators for smallholder coffee farms

		Financial Capital	Human Capital	Natural Capital	Physical Capital	Social Capital
Farm Level	Absorptive Capacity	Net income/ poverty level	Food security and nutrition	On-farm soil health	Access to early-warning Systems	Access to informal safety nets
	Adaptive Capacity	Use of credit	Use of relevant climate smart agricultural practices	Access to “climate-ready” ¹⁸ varieties of focus crop	Access to climate change projections	Access to knowledge-sharing groups re: climate change
	Transformative Capacity	Saving sufficient for on-farm investment	Innovation potential	Access to quality planting material for alternative, climate-ready crops	Access to alternative, climate-ready value chains	Quality of enabling environment



CASE STUDY: Keurig Green Mountain and its Coffee Under Pressure project

To assess the resilience capacity of coffee suppliers within the countries of interest, the project partners developed a diagnostic tailored to smallholder coffee production in Central America. Project partners worked with local coffee suppliers, including farmers and farmer cooperatives, to identify proxy indicators in the form of measurable assets, characteristics, or practices that likely influence resilience capacity, with a focus on absorptive and adaptive capacities.¹⁸ The CUP project used the Sustainable Livelihoods Framework to organize indicators by asset or capital types (i.e., financial human, natural, physical, and social). See the Resources section for links to the specific indicators used.

The team then scored coffee farmer performance on each resilience capacity indicator, using semi-structured interviews to assign a score from 1 (low) to 5 (high). The team translated the diagnostic scores into a resilience index designed to categorize farming families by low, medium, or high absorptive or adaptive capacity to inform future programming.

In Nicaragua, for example, the project team found generally low resilience due to limitations across a number of capitals, including financial (e.g., pervasive poverty), human (e.g., extensive out-migration), and physical (e.g., deficient post-harvest infrastructure).

¹⁸ Note that, for consistency, we have adapted the CUP project's terminology to align with the terms used in this guide in the case studies. The CUP project focused on measuring farmer vulnerability to climate change, which it defined as a function of crop exposure to climate change risk, and of farmers' absorptive capacity (defined by the project as "sensitivity") and adaptive capacity. As discussed at the beginning of this guide, we see resilience and vulnerability as two sides of the same coin.

In cases where climate change exacerbates current supply chain risks, indicators may look similar to existing supply chain risk or sustainability indicators. Where climate change introduces new threats, indicators may lead companies into new performance measurement themes.

By breaking resilience capacities down into contributing assets, companies can quickly identify the strengths and weaknesses of farmers or intermediate aggregators. For example, if suppliers have sufficient capital in all areas except those related to physical capital, a company may prioritize investments in supply chain infrastructure.

At this stage in the process, companies can choose how to "score" suppliers' resilience capacities. After collecting data on supplier performance under each indicator (e.g., income), companies may rank suppliers on a continuum or may bucket suppliers into resilient/not resilience categories based on cut-off thresholds (e.g., an income floor deemed necessary for resilience in that context).



INTRODUCTION

ABOUT
THIS GUIDE

RESILIENCE &
CLIMATE SMART
AGRICULTURE

GUIDING
STEPS

COMMON
INDICATORS

RESOURCES

KNOW HOW TO BUILD RESILIENCE





See
Resources
section for
more
information

4. KNOW HOW TO BUILD RESILIENCE: DESIGNING STRATEGY OR TARGETED INTERVENTIONS IN RESPONSE TO DIAGNOSTIC FINDINGS

Ultimately, climate resilience data is only effective when used to inform business strategy or targeted interventions. Once companies understand the climate risk exposure within their supply chain, identify priority suppliers, and diagnose the resilience capacity of these suppliers, they can use this data to design targeted resilience interventions.

The process of designing and implementing resilience interventions fall outside the scope of this guide, but we include this section as the natural next step in this process. We direct readers to the “Resources” section. Readers may wish to start with the “Program Support” resources developed by the Research Program on Climate Change, Agriculture and Food Security (CCAFS).¹⁹ The resilience diagnostic will be used, along with other available information and lessons learned from implementation to “innovate in product design, including both adapting materials for local conditions and/or develop(ing) new ideas for spreading information when appropriate.” The results of that exercise will then be “iterate(d), with end-users to field-test, refine and improve the materials.”

¹⁹ CCAFS. “Climate-Smart Agriculture 101.” <https://csa.guide/csa/programme-support>

CASE STUDY: Keurig Green Mountain and its Coffee Under Pressure project

After the CUP team identified resilience gaps, they worked with farmer households to prioritize key vulnerability areas and brainstorm solutions. Households emphasized efforts to build natural capital via more sustainable resource management; human capital via training on good agricultural practices; and financial capital via improved access to credit to invest in their farmers. Keurig, CRS, and CIAT used this analysis for the multi-year livelihoods program funded by Keurig, which included credit and advisory services for farmer cooperatives from Root Capital.

INTRODUCTION

ABOUT
THIS GUIDE

RESILIENCE &
CLIMATE SMART
AGRICULTURE

GUIDING
STEPS

COMMON
INDICATORS

RESOURCES

KNOW YOUR PROGRESS





See
Resources
section for
more
information

5. KNOW YOUR PROGRESS: MONITORING THROUGH CONTINUOUS MEASUREMENT

To track progress against resilience objectives, companies will need to regularly monitor the conditions on the ground. This will include monitoring short-term climate variability, climate-related shocks, and longer-term climate change; as well as monitoring activities put in place to build resilience within farming communities. Companies may leverage indicators used during the diagnostic phase to track performance throughout the program cycle. At this stage, companies who used “threshold” metrics in the diagnostic phase may transition to using more of a continuum approach, where resilience is measured in terms of progress relative to a baseline rather than in terms of a defined level that is considered “appropriate.”

Performance measurement can be scheduled at regular intervals to inform program/strategy iteration and to communicate progress both internally and externally. In this way, performance measurement is a continuous process of moving from data to action.

There are several methodological and process decisions a company must make when designing and implementing a performance management plan, including the academic rigor involved, the specific indicators to track, the data collection schedule, and whether to conduct the process in-house or hire a third party.²⁰ There is no one-size-fits-all approach. Companies have discretion to shape their performance measurement plan to shape their performance measurement plan in light of their specific objectives.

²⁰ More information on performance measurement can be found in the Toward a Shared Approach to Smallholder Performance Measurement documents created by the Smallholder Performance Measurement Community of Practice. For general information on Performance measurement, see the Shared Approach document here: <http://www.sustainablefoodlab.org/performance-measurement/tools-resources/deep-dive/> and for more information on developing an approach to performance measurement, visit here: <http://www.sustainablefoodlab.org/performance-measurement/tools-resources/developing-an-approach-to-performance-measurement-a-practitioners-guide/>.

COMMON INDICATOR FRAMEWORK

On the next page, we suggest topline indicators for measuring climate resilience in smallholder supply chains, at both the farmer household and farmer aggregator (e.g., cooperative) level. We organize indicators by resilience capacity (absorptive, adaptive, and transformative – see page 7 for definitions) and by livelihood asset (financial, human, natural, physical, and social – see page 20 for definitions). Indicators are based on a literature review and the direct field experience of the Learning Community.

Together, the indicators form a continuum, with absorptive capacity indicators “laddering up” through adaptive capacity to transformative capacity. The line between capacities can be blurry, as some indicators could fall into several capacities depending on context. For simplicity, we assigned indicators to one category, but we encourage readers to reorganize indicators according to their needs.

For readers looking for detailed guidance on metrics selection or field collection, the Resources section lists further reading, including methodology guides and indicators menus, and contacts for technical experts in measuring smallholder resilience.

Farm Level

	Financial Capital	Human Capital	Natural Capital	Physical Capital	Social Capital
Absorptive Capacity	Net income/poverty level	Food security and nutrition	On-farm soil health	Access to early-warning systems	Access to informal safety nets
	Savings sufficient for emergencies	Labor for focus crop	On-farm water health	Weather-proof post-harvest infrastructure	
	Insurance	Access to technical assistance	On-farm biodiversity	Weather-proof transportation infrastructure	
Adaptive Capacity	Income diversification	Use of climate-smart practices	Access to climate-ready varieties of focus crop	Access to climate change projections	Access to knowledge-sharing groups re: climate change
	Access to credit		Altitude for altitude-sensitive crops	Access to clean & appropriate technologies	Participation in local decision-making
Transformative Capacity	Savings sufficient for investment	Innovation potential	Access to quality planting material for alternative, climate-ready crops	Access to alternative, climate-ready value chains	Quality of enabling environment
					Participation in decision-making structures affecting farming community

Intermediary Aggregator Level					
	Financial Capital	Human Capital	Natural Capital	Physical Capital	Social Capital
Absorptive Capacity	Profitability	Management experience in target crop	Access to water	Energy reliability	
	Financial stability	Management capacity		Weather-proof facilities	
	Liquidity	Employee loyalty		Weather-proof transportation infrastructure	
	Insurance	Supplier loyalty			
Adaptive Capacity		Supplier engagement for cooperatives			
		Succession plan	Access to renewable energy	Facilities control	Access to knowledge-sharing groups re: climate change
		Investment in employee development	Access to climate-ready varieties of focus crop		
		Investment in extension			
Transformative Capacity	Access to buyers for alternative, climate-ready crop	Innovation potential (likelihood of innovating)	Access to planting material for alternative, climate-ready crop	Access to alternative, climate-ready value chains	Access to industry network re: alternative, climate-ready crop
	Access to start-up capital	Management experience in alternative crops			"Stickiness" of current suppliers (willingness to follow business into new crop)
		Access to suppliers of alternative, climate-ready crop			

GENERAL RESOURCES

Climate Change, Agriculture and Food Security (CCAFS): Climate Smart Agriculture 101

CGIAR's Research Program on Climate Change, Agriculture and Food Security (CCAFS) provides a definition of climate smart agriculture and resources to guide practitioners on how to implement climate smart practices. For more information, see: <https://csa.guide/>

Conservation International

Conservation International has produced a body of work on ecosystem-based adaptation, focusing on conservation, sustainable management and restoration of natural ecosystems to help people adapt to climate change. The resources include both diagnostic information as well as recommended strategies and practices. For more information, please see: <https://www.conservation.org/projects/Pages/adapting-to-climate-change-ecosystem-based-adaptation.aspx>

Bouroncle, C., Imbach, P., Rodríguez, B., Medellín, C., Martínez-Valle, A., Läderach, P. (2017) Mapping climate change adaptive capacity and vulnerability of smallholder agricultural livelihoods in Central America: ranking and descriptive approaches to support adaptation strategies. *Climatic Change*, 141 (1) 123-127.

Ecosystem-based Adaptation is essential for achieving the Sustainable Development Goals. Conservation International policy brief (distributed at COP 21)

Harvey, C.A., M.R. Martínez -Rodríguez, J. M. Cardenas, J. Avelino, B. Rapidel, C.I. Donatti, and Vilchez Mendoza. The use of Ecosystem-based Adaptation practices by smallholder farmers in Central America. *Agriculture, Ecosystems and Environment* 246: 279-290. <http://www.sciencedirect.com/science/article/pii/S0167880917301810>

Smallholder Farmers and Ecosystem-based Adaptation. Conservation International policy brief (distributed at COP21)

COSA: Resilience Metrics

The majority of the farm-level indicators are taken from the Committee on Sustainability Assessment (COSA) work on Resilience, which illustrates indicators (social, economic and environmental) identified through a thorough review of the current scientific literature on resilience, disaster risk, and vulnerability as well as close interactions with many of the leading efforts in the field (FAO, CIAT, USAID, etc.) to distill their best practices. The Learning Community has referenced those indicators that are the most relevant to climate resilience and tailored others to pertain more directly to climate resilience or the surveying needs of food and beverage companies. COSA resilience indicators can be found at: <https://data.thecosa.org/indicators-resilience/>. To learn more, contact COSA: <https://thecosa.org>.

COSA (2017): *Simpler Resilience Measurement: Tools to Diagnose and Improve How Households Fare in Difficult Circumstances from Conflict to Climate Change*. Committee On Sustainability Assessment (PA), Ford Foundation (NY).

Serfilippi, E. and Ramnath, G., 2018, "Resilience Measurement and Conceptual Frameworks: A Review of the Literature" forthcoming in *Annals of Public and Cooperative Economics*.

1. KNOW YOUR RISK

CCAFS: CSA Country Profiles

Quick and easy to read, the Climate-Smart Agriculture (CSA) country profiles give an overview of the agricultural challenges in countries around the world, and how CSA can help them adapt to and mitigate climate change. For more information, see: <https://ccafs.cgiar.org/publications/csa-country-profiles>.

Food Security Information Network, Resilience Measurement Technical Working Group: Measuring Shocks and Stressors as Part of Resilience Measurement

This publication in the Resilience Measurement Technical Series presents methods for measuring shocks and stressors threatening resilience. For more information see: <http://www.fsincop.net/topics/resilience-measurement/outupts/en/>.

Germanwatch: Global Climate Risk Index

The Global Climate Risk Index analyses to what extent countries have been affected by the impacts of weather-related loss events (storms, floods, heat waves etc.). For more information, see: <https://germanwatch.org/en/12978>.

Global Forest Watch

GFW Climate catalyzes action on climate change by providing timely, credible answers to questions about carbon emissions from tropical deforestation. For more information, see: <http://climate.globalforestwatch.org/>.

International Center for Tropical Agriculture (CIAT): Climate Change Exposure Maps

CIAT has produced Climate Change Exposure maps (such as the one highlighted in the guide above) for many specific geographies and crops to provide insights into the severity of impact in certain agro-ecological zones. Please see CIAT's website for many climate smart agriculture and resilience resources and/or contact them directly for more information on exposure maps: <http://ciat.cgiar.org/>.

University of Notre Dame: ND-GAIN Country Index

The ND-GAIN Country Index summarizes a country's vulnerability to climate change and other global challenges in combination with its readiness to improve resilience. It aims to help governments, businesses and communities better prioritize investments for a more efficient response to the immediate global challenges ahead. For more information, see: <http://gain.nd.edu/our-work/country-index/>.

USAID: Climate Links

In addition to the Climate Risk Screening and Management Tools, a number of resources are available to support USAID's implementation of climate risk management within USAID, including a guide for monitoring, evaluation, learning and knowledge management, and a primer on using climate information. For more information see: <https://www.climatelinks.org/integration/climate-risk-management/resources>.

Verisk Maplecroft: Risk Calculators and Dashboards

The new Climate Change Vulnerability Index (CCVI), released by global risks advisory firm Maplecroft, enables organisations to identify areas of risk within their operations, supply chains and investments. For more information, see: <https://maplecroft.com/about/news/ccvi.html>.

The World Bank: Climate Risk and Adaptation Country Profiles

This series of 94 climate risk and adaptation profiles offers a common platform to guide access, synthesis, and analysis of relevant country data and information for Disaster Risk Reduction and Adaptation to Climate Change. The profiles are geared towards providing a quick reference source for development practitioners to better integrate climate resilience in development planning and operations. Users are able to evaluate climate-related vulnerability and risks by interpreting climate and climate-related data at multiple levels of detail. For more information see: http://sdwebx.worldbank.org/climateportalb/home.cfm?page=country_profile&CCode=&ThisTab=Overview.

For basic data or methodologies on conducting climate impact analysis, refer to:

AgMIP (Agricultural Model Intercomparison and Improvement Project) Climate Team: <http://www.agmip.org/climate-team/>

CCAFS' MarkSimGCM Tool: <https://ccafs.cgiar.org/marksimgcm-weather-generating-tool#.WZHjXneGNTY>, and CCAFS' Climate Wizard: <https://ccafs.cgiar.org/climate-wizard#.WZHjhneGNTY>

FAO's MOSAICC: <http://www.fao.org/climatechange/mosaicc/en/>

2. KNOW YOUR FARMERS

3. KNOW YOUR RESILIENCE

CARE: Climate Vulnerability and Capacity Analysis

CARE's most popular practitioner guide, this community-level tool integrates climate change into a wider participatory vulnerability analysis. See: <http://careclimatechange.org/tool-kits/cvca/>.

Centro Agronómico Tropical de Investigación y Enseñaza (CATIE): Identificación de la vulnerabilidad en los medios de vida de las familias cafetaleras y sus posibles estrategias de adaptación al cambio climático en el norte de Nicaragua

CATIE's Spanish language guide provides a step by step process for diagnosing and designing participatory solutions for climate change adaptation and resilience building in coffee farmers. For more information, please see: <https://www.catie.ac.cr/>.

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GIZ: Framework for Climate Change Vulnerability

For additional conceptual guidance, GIZ's Framework for Climate Change Vulnerability Assessment provides

an overview of a large range of tools and approaches. For more information, please see: http://www.adaptationcommunity.net/?wpfb_dl=236.

Initiative for coffee&climate: Toolbox, Risk Analysis Tools

The c&c approach provides practical orientation on how to increase the climate resilience of smallholder coffee farmers. The initiative has documented its approach via a detailed, step-by-step manual that offers best practice related to field diagnostics, risk analysis, monitoring and evaluation, and via a toolbox with practical climate adaptation and mitigation tools. For more information see the initiative's open online platform: <http://toolbox.coffeeandclimate.org/>.

USAID Feed the Future: Community Resilience: Conceptual Framework and Measurement

USAID's Feed the Future focuses on a framework for measuring community resilience to apply to policy or programming initiatives. For more information, see: https://agrilinks.org/sites/default/files/resource/files/FTF%20Learning_Agenda_Community_Resilience_Oct%202013.pdf.

USAID Feed the Future Alliance for Resilient Coffee: Coffee Farmer Climate Vulnerability Measurement Tool

The Alliance for Resilient Coffee is creating a farm-level survey tool to measure a farmer household's vulnerability, including adaptive capacity, to climate shocks. The tool analyzes vulnerability across five domains: local climate conditions, soil management, crop management, water and forest management, and household finances. The tool is in testing and is not yet publicly available. For more information, please contact Katherine Selengia at katherine.selengia@hrnstiftung.org.

4. KNOW HOW TO BUILD YOUR RESILIENCE

CARE: Toolkit for Integrating Climate Change Adaptation into Development Projects

This toolkit offers practical, "how to" guidance for integrating climate change adaptation into the design,

implementation, monitoring and evaluation of development projects. Its step-by-step structure helps users build climate-resilient projects with sustainable impacts. See: <http://careclimatechange.org/tool-kits/integrating-cc/>.

Centro Agronómico Tropical de Investigación y Enseñaza (CATIE): Identificación de la vulnerabilidad en los medios de vida de las familias cafetaleras y sus posibles estrategias de adaptación al cambio climático en el norte de Nicaragua

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Rainforest Alliance

The Rainforest Alliance is an international non-profit organization working to build strong forests, healthy agricultural landscapes, and thriving communities through creative, pragmatic collaboration. Part of their work includes building resilience to climate change, with active engagements in coffee, cocoa, and other crops around the world. For more information, see: <https://www.rainforest-alliance.org/issues/climate>.

5. KNOW YOUR PROGRESS

CCAFS: Measuring Progress Towards the WBCSD Statement of Ambition on Climate-Smart Agriculture:

Improving Businesses' Ability to Trace, Measure and Monitor CSA

This CCAFS working paper provides guidance provides a simple framework, sets of recommended indicators, and a stock-take of the current status of CSA progress, both globally and among WBCSD member companies. For more information see: <https://cgspace.cgiar.org/rest/bitstreams/93637/retrieve>.

CCAFS: A Monitoring Instrument for Resilience

This CCAFS working paper describes a monitoring instrument for efficiently tracking changes in resilience in agricultural initiatives. The instrument seeks to balance the demands for tracking and reporting changes in resilience with the time and resource constraints typical of development initiatives. For more information see: <https://ccaafs.cgiar.org/publications/monitoring-instrument-resilience#.Wn3YlyXwblU>.

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Food Security Information Network, Resilience Measurement Technical Working Group: Resilience Measurement Principles; A Common Analytical Model for Resilience Measurement

These two publications in the Resilience Measurement Technical Series describe ten key design principles for resilience measurement and propose an analytical model for measurement, with a particular focus on resilience for food security. For more information see: <http://www.fsincop.net/topics/resilience-measurement/outupts/en/>.

Oxfam: A Multidimensional Approach to Measuring Resilience

Oxfam describes its approach for both understanding and measuring resilience, using a multidimensional framework that takes into account issues like poverty and women's empowerment. For more information, see: <https://policy-practice.oxfam.org.uk/publications/a-multidimensional-approach-to-measuring-resilience-302641>.

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